

Conferences and Reviews

Overview of Anesthesia for Primary Care Physicians

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Primary care physicians are frequently asked to evaluate patients before elective surgery. Familiarity with anesthetic technique and physiologic processes can help primary care physicians identify risk factors for perioperative complications, optimize patient care, and enhance communication with surgeons and anesthesiologists. To this end, we review the physiologic processes accompanying tracheal intubation and general and regional anesthesia. There is no convincing evidence that regional anesthesia is safer than general anesthesia. In addition to replacing fluid losses from the surgical field and insensible losses, intraoperative fluid administration may attenuate the cardiovascular and renal effects of anesthesia. Therefore, recommendations to limit fluids should be made with caution and should be tempered with an understanding of intraoperative fluid requirements. An understanding of the physiologic processes of anesthesia, combined with preoperative risk stratification strategies, will enhance a primary care physician's ability to provide meaningful preoperative evaluations.

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Primary care physicians frequently evaluate patients before a surgical procedure. Primary care residencies have not emphasized preoperative evaluations as part of their curriculum, leaving most practitioners without formal training in this important area. For preoperative evaluations, the physiologic changes accompanying anesthesia and how these changes will affect a patient's underlying medical problems should be considered. In this article, we focus on the physiologic changes accompanying general and regional anesthesia. Our goal is to provide primary care physicians with an appreciation of anesthetic techniques and processes. In conjunction with other tools, this knowledge will enhance primary care physicians' ability to assess their patients' perioperative risks.^{1–5}

Communication among the primary care physician, anesthesiologist, and surgeon is an essential component of a preoperative evaluation. Communication is enhanced if primary care physicians are familiar with the American Society of Anesthesiologists' classification (Table 1).⁶ This classification system is the most widely used tool to assess a patient's preoperative condition and perioperative risks. The assignment of risk is based on the patient's physical status independent of the planned operation. The classification is composed of five levels representing increasing perioperative risk; the letter "E" is added to indicate further increased risk associated with emergency surgery. Despite the fact that the American Society of Anesthesiologists' classification is subjective and inconsistencies have been demonstrated, it predicts mortality

and correlates with length of hospital stay. Furthermore, it has been shown to be equivalent to other more complex methods of assessing perioperative risks.⁷

The goals of anesthesia are to provide analgesia and relaxation for surgery while rendering the patient amnesic for the operative events. An anesthesiologist can achieve these goals with general, regional, or local anesthesia. The choice of anesthetic technique is often determined by surgical needs—patient position or the need for relaxation—patient status, and patient preferences. No evidence exists that one technique is safer than another. The many subtleties regarding anesthetic drugs and techniques are mastered during anesthesiology training. The choice of anesthesia is the domain of the anesthesiologist, and primary care physicians should refrain from making recommendations regarding the type of anesthesia to be used during a surgical procedure.

Anesthetic premedication is an integral part of the anesthetic plan regardless of the technique being used. These medications are usually administered before a patient is transported to the operating room. They provide sedation, anxiolysis, and amnesia during the perioperative period. The most commonly used premedication is midazolam hydrochloride because of its rapid onset of action, short half-life, and superior amnesic qualities. Under the effects of premedications, patients are awake and responsive but will be amnesic about their anesthetic and surgical events. Primary care physicians can play an important role by reassuring their patients about this aspect of the perioperative experience.

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ABBREVIATIONS USED IN TEXT

LMA = laryngeal mask airway

MAC = monitored anesthesia care

General Anesthesia

General anesthesia and unconsciousness are usually induced with the intravenous administration of drugs such as barbiturates, opiates, and recently, propofol, a new sedative-hypnotic agent.^{8,9} Once unconsciousness is induced, anesthesia is maintained with a combination of agents including inhaled anesthetics, opiates, propofol, and neuromuscular blocking drugs. The inhaled anesthetics can be administered by a face mask, laryngeal mask airway (LMA), or endotracheal tube. General anesthesia does not always involve tracheal intubation, but if prolonged neuromuscular blockade is needed or if pulmonary aspiration of gastric contents is possible, then tracheal intubation is mandatory. Neither the face mask nor the LMA protects the lungs from aspiration. The LMA was introduced in 1988 and is gaining popularity because it provides an effective airway and does not require direct visualization of the larynx or the use of a laryngoscope for insertion. It is inserted through the mouth and positioned so that the distal end, once inflated, forms an oval seal around the laryngeal inlet above the vocal cords. The LMA is useful for airway management in a patient who may otherwise be difficult to ventilate or intubate and as a guide for subsequent fiberoptic intubation. It is not recommended for use in long operations (>2 to 3 hours), for intra-abdominal or intrathoracic operations where neuromuscular blockade or prolonged mechanical ventilation is needed, or in any situation where the risk of gastric aspiration is present.¹⁰

Tracheal intubation is often considered the optimal airway management technique for general anesthesia. Primary care physicians should be aware that difficult intubations may occur; that teeth may be damaged, broken, or inhaled; and that hemodynamic stresses accompany tracheal intubation. Direct laryngoscopy and tracheal intubation are associated with sympathetic nervous system activation and increases in blood pressure and heart rate. These hemodynamic changes occur during laryngoscopy, rapidly reach a plateau, and then return to baseline after four to five minutes.^{11,12} These sympathetic responses to tracheal intubation may be exaggerated in hypertensive patients whose blood pressure is not well controlled preoperatively. These changes are clinically important because they may result in myocardial ischemia.^{11,13,14} Many pharmacologic regimens have been proposed to diminish the hemodynamic response to tracheal intubation, but there is no consensus regarding which regimen is most effective.¹⁵⁻¹⁸

Following anesthesia induction, the inhaled anesthetics halothane, enflurane, isoflurane, desflurane, sevoflurane, and nitrous oxide, generally in combination with opiates, are used to maintain anesthesia.^{8,19} Although each of these drugs has individual properties, their cardiovascular effects will be discussed in general terms. The

inhaled anesthetic agents reduce arterial blood pressure by decreasing systemic vascular resistance, myocardial contractility, and stroke volume. Patients with a history of congestive heart failure and impaired myocardial contractility are particularly sensitive to this drug-induced myocardial depression. The decrease in myocardial contractility can be partially offset by preoperative volume loading through the Frank-Starling mechanism.^{8,20} Interestingly, a retrospective study reported that postoperative congestive heart failure occurred more commonly in patients who had received less intravenous fluids than in patients in whom heart failure did not develop.²¹ Several hypotheses have been proposed to explain this paradoxical observation, but none have been studied prospectively, and no firm conclusions can be drawn.

The inhaled anesthetics appear to protect the myocardium from ischemic injury. The mechanisms for this myocardial protection are incompletely understood, but coronary artery dilatation, diminished myocardial oxygen consumption, and cellular metabolic changes play important roles.^{22,23} Despite this protection, myocardial ischemia may develop in patients with coronary artery disease and minimal reserves when surgical manipulation activates the sympathetic nervous system and increases myocardial oxygen consumption.⁸ The inhaled anesthetics can sensitize the myocardium to the effects of circulating catecholamines, which may result in ventricular irritability and premature ventricular extrasystoles. Halothane suppresses sinus node activity and can cause intraoperative junctional rhythms. These rhythms are usually well tolerated except in patients with mitral stenosis or stiff left ventricles who depend on atrial systole for ventricular filling.⁸

As mentioned earlier, the inhaled anesthetic agents reduce the arterial blood pressure by decreasing systemic vascular resistance, myocardial contractility, and stroke volume.⁸ This hypotensive response on induction is exaggerated in hypertensive patients.^{14,24} Surgical stimulation and emergence from anesthesia are associated with sympathetic nervous system activation and increases in blood pressure and pulse. Again, these intraoperative hemodynamic changes are more pronounced among hypertensive patients. These exaggerated responses are

TABLE 1.—Mortality Rates According to American Society of Anesthesiologists (ASA) Classification*

ASA Class	Definition	Mortality, %
I	Normal healthy patient	0.08
II	Mild to moderate systemic disease	0.27
III	Severe systemic disease that limits activity but is not incapacitating	1.8
IV	Incapacitating systemic disease that is a constant threat to life	7.8
V	Moribund patient not expected to survive 24 hr with or without surgery	9.4

*From American Society of Anesthesiologists.⁶

important because intraoperative hemodynamic lability is associated with postoperative complications.^{21,24,25} Primary care physicians evaluating patients for surgery must have an appreciation of these intraoperative changes because they affect the preoperative risk assessment and may alter postoperative management.

The inhaled anesthetics have multiple effects on respiration and ventilation. "Hypoxic pulmonary vasoconstriction" is a normal reflex constriction of pulmonary arterioles in hypoxic regions of lung that reduces the perfusion of hypoventilated alveoli. This reflex vasoconstriction may be altered or inhibited by the inhaled anesthetics.²⁶ General anesthesia also causes decreased functional residual capacity and atelectasis. The mechanisms for these changes are multifactorial and include patient position (supine as opposed to upright) and altered thoracic configuration due to respiratory muscle relaxation. Thus, patients with underlying lung disease will have an increased ventilation-perfusion mismatch and hypoxia. The inhaled anesthetics not only produce the physiologic perturbations described above, they also attenuate normal compensatory responses. As a result, patients receiving inhaled anesthetics require supplemental oxygen and may require controlled ventilation. In addition to these changes, the inhaled anesthetics inhibit mucociliary function and impair secretion clearance, increasing the risk of aspiration and infection.^{8,27,28}

Anesthetic drugs can alter renal function through their effects on the systemic circulation and the sympathetic nervous system. Reductions in renal blood flow, glomerular filtration rate, and urinary output occur with anesthesia and surgery. These changes are multifactorial. Renal blood flow may decrease during general anesthesia as the systemic blood pressure and cardiac output fall. The autoregulation of renal blood flow remains intact under the influence of anesthetic drugs, and renal blood flow is constant until the mean arterial blood pressure falls below 50 mm of mercury. If the mean arterial blood pressure falls below this level, renal blood flow and glomerular filtration rate will also decrease.^{29,30} Thus, in most cases, intraoperative reductions in urinary output cannot be explained by hemodynamic factors alone. The antidiuretic hormone appears to play an important role in decreasing urinary output during a surgical procedure. Antidiuretic hormone is released in response to noxious stimuli from the surgical site and baroreceptor stimulation with positive pressure ventilation.³¹ The reductions in renal blood flow and glomerular filtration rate and the increased antidiuretic hormone levels are attenuated with preoperative intravenous volume loading.³²

In addition to the above-noted cardiac and renal concerns, there are other reasons for fluid administration during anesthesia and surgery. Insensible losses must be replaced (2 ml per kg per hour), along with additional fluids to counteract the losses occurring from the surgical field. The amount of fluid that must be replaced is dependent on the surface area exposed and the estimated surgical trauma (3 to 8 ml per kg per hour). Until transfusion becomes necessary, minor blood losses are

replaced by a factor of 3 ml of a crystalloid solution per 1 ml of blood lost.³³ Thus, intravenous fluid administration is an important component of anesthetic management. Physicians evaluating patients before surgery need to be aware of these fluid requirements and to recommend fluid restriction with caution.

Regional Anesthesia

Regional anesthetic techniques include spinal, epidural, intravenous, and peripheral nerve blocks. In contrast to general anesthesia, regional anesthesia is not easily reversible once established. Regional anesthesia occasionally fails to provide adequate analgesia and needs to be converted to general anesthesia.³⁴ Because of this, a preoperative risk assessment must consider the possibility of general anesthesia being required.

Epidural and spinal techniques may produce substantial physiologic changes. Spinal anesthesia is produced by injecting local anesthetic directly into the lumbar intrathecal space to block spinal nerve roots, whereas epidural anesthesia relies on the diffusion of anesthetic from the epidural space to nearby spinal roots to produce neural blockade. The disadvantages of spinal anesthesia include difficulty controlling the level of anesthesia and the occurrence of a postanesthetic headache.³⁵ Epidural anesthesia requires a larger volume of anesthetic, which is injected into the highly vascular epidural space. The inadvertent injection of anesthetic into a blood vessel can result in a systemic toxic reaction. In addition, the unintentional subarachnoid administration of large amounts of anesthetic can result in total spinal anesthesia, which is manifest by profound hypotension and respiratory arrest.³⁵

Although the physiologic processes of spinal and epidural anesthesia are similar, the effects of epidural anesthesia are more gradual in onset. Venodilation occurs with both techniques and can result in decreased preloading, decreased cardiac output, and hypotension. Patients with volume depletion and higher-level blocks have the greatest falls in blood pressure. If the block is sufficiently high (involving T-1 to T-4), a compensatory tachycardia in response to hypotension does not occur because cardiac sympathetic fibers are blocked. Preoperative volume loading can attenuate the hypotension accompanying regional anesthesia, but postoperative congestive heart failure may occur as the anesthetic wears off and venous tone returns to normal. Regional anesthesia involving lower sensory levels usually does not affect respiratory function, but higher sensory levels are associated with decreases in inspiratory capacity and expiratory reserve volume, as well as an impaired cough.³⁵

Comparisons Between General and Regional Anesthesia

General anesthesia and surgery are associated with predictable neuroendocrine changes due to sympathetic nervous system activation. Plasma cortisol and cate-

choline levels increase intraoperatively and remain elevated until the fourth postoperative day.^{36,37} During surgery, insulin release from the pancreas is inhibited, and insulin levels may be 50% lower than expected.³⁸ Diminished insulin secretion and the release of counter-regulatory hormones can result in hyperglycemia that persists well into the postoperative period. These neuroendocrine changes are less pronounced when regional anesthetic techniques are used. The neural blockade produced with regional anesthesia prevents the afferent transmission of noxious stimuli from the surgical site. Because afferent transmission is interrupted, reflex activation of the sympathetic nervous system and the accompanying neurohumoral changes do not occur.³⁷ Whether these differences in neuroendocrine function are clinically relevant is uncertain.

Many clinicians think that regional anesthesia is safer than general anesthesia in high-risk patients. Little data exist to support this opinion. Prospective randomized studies comparing general and regional anesthesia have shown no differences in mortality, cardiopulmonary complications, or postoperative cognition.^{39–42} There may, however, be differences that influence the choice of anesthetic technique. Recent studies have suggested improved vessel patency rates when lower extremity vascular surgery is performed under regional anesthesia.^{40,43} Other data suggest that the incidence of proximal deep venous thrombosis may be reduced when regional anesthesia is used for lower extremity joint replacement.^{44,45}

Combined General and Regional Anesthesia

Combined general and regional anesthesia is sometimes used for high-risk patients undergoing a surgical procedure. Compared with general anesthesia alone, the combined technique is associated with more stable intraoperative hemodynamics and a shorter duration of postoperative mechanical ventilation.^{46,47} Although some studies have reported decreased cardiopulmonary complications and decreased mortality, these results have not been consistent.^{46–48}

Monitored Anesthesia Care—Local Anesthesia With Sedation

Monitored anesthesia care (MAC) is a common form of anesthetic management used for procedures that are short and involve minimal surgical stimulation—for example, cataract surgery or breast biopsy. Monitored anesthesia care typically uses brief, deep intravenous sedation to decrease awareness of the administration of local anesthesia, followed by lower doses of sedatives and narcotics titrated to patient comfort.

Although this type of anesthesia allows the patient to be comfortable and usually amnestic to painful stimuli, there are no data to support the popular notion that MAC is safer than other forms of anesthesia. When evaluating patients for surgery with MAC, consideration should be given to the possibility that general anesthesia may be

required. Patients may not tolerate the procedure under MAC or the surgeon may find the procedure to be more involved than anticipated. Frequently a surgical procedure requires that the anesthesiologist be placed away from the patient's airway and therefore in a difficult position should problems arise. Preoperative "nothing by mouth" guidelines should be followed for MAC as well as other forms of anesthesia because of the risk of pulmonary aspiration. Because patients may have substantial cardiopulmonary stresses with MAC, its use can be more dangerous for sick or critically ill patients than either regional or general anesthesia. Although primary care physicians play an important role in reassuring their patients about the sedative and amnestic components of MAC, they should refrain from advising patients or other physicians that a surgical procedure should be done only with the use of local anesthesia.

Conclusion

Evaluating patients before an elective surgical procedure requires an awareness of anesthetic techniques and their accompanying processes. This knowledge will help primary care physicians to perform preoperative risk assessments. A meaningful preoperative evaluation considers the effects of anesthesia and surgery on a patient's underlying medical problems and should include the following: a recent and legible complete history and physical examination; a general interpretation of the patient's health status (for example, a patient has had a myocardial infarction but currently has excellent exercise tolerance without evidence of residual ischemia or congestive heart failure); and a notation about special medical issues (previous response or lack of response to various antihypertensive medications or idiosyncratic reactions to medications). Recommendations should be as specific as possible, and the primary care physician should avoid obvious, general recommendations such as "avoid hypotension and hypoxia." Primary care physicians should also refrain from making recommendations regarding the choice of anesthetic technique.

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